Attorney Docket No. 56702 (70801)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Nobuyuki Takamori, *et al.*

Application No.: 10/002,949

Confirmation No.: 5456

Filed: November 15, 2001

Art Unit: 1756

For: OPTICAL DATA RECORDING MEDIUM

Examiner: M. J. Angebranndt

Mail Stop Appeal Brief—Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

BRIEF ON APPEAL

Sir:

This is an appeal from the final rejection of claims 10-22, as included in the Final Office Action mailed by the U.S. Patent and Trademark Office on February 2, 2006.

BRIEF ON APPEAL FEE

Authorization to charge Deposit Account No. 04-1105 for $500.00, covering the appeal brief fee, is provided herewith. However, if for any reason a fee is required, a fee paid is inadequate or credit is owed for any excess fee paid, the Commissioner is hereby authorized and requested to charge Deposit Account No. **04-1105**.

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REAL PARTY IN INTEREST

The real party in interest is Sharp Kabushiki Kaisha. The assignment of the inventors to this corporation was recorded on November 15, 2001, at Reel 012355, Frame 0205.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences known to Appellants, Appellants' legal representative, or the assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal. However, certain related issues were raised by the appeal filed in co-owned application serial no. 10/002,952.

STATUS OF CLAIMS

Claims 1-22 have been presented in this application. Claims 1-9 have been cancelled. Claims 10-22 stand finally rejected. Claims 10-22 are appealed. See the Claims Appendix attached hereto.

STATUS OF AMENDMENTS

No amendments were filed after final rejection.

A clean set of the claims on appeal is set forth in the Claims Appendix hereto.

SUMMARY OF CLAIMED SUBJECT MATTER

Independent claims 10, 14 and 18 are pending in the application.

The present invention provides optical data recording medium which are resistant to deformation (e.g., warp) due to changes in temperature. More particularly, the present invention provides optical data recording media in which the expansion coefficient of the protective film and the transparent substrate are regulated to prevent a bending force that can induce a warp or bend in the medium (see, e.g., page 6, lines 10-13). The present inventors have discovered that selecting the materials used in the protective layer and the transparent substrate provides superior thermal stability and reduced medium deformation.

Independent claim 10 recites an optical data recording medium comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein the thin film layer is a single layered or multilayered film including at least any one of a dielectric film, a recording film and a reflective film (see, e.g., page 6, lines 14-21). In claim 10, at least either one of a linear expansion coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate, and the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (l/°C) (see, e.g., page 21, lines 10-18, and Figure 5) and smaller than 5.0×10^{-4} (1/°C), and an expansion coefficient under humidity of the protective film is 1.7×10^{-4}(1/%) or smaller (see, e.g., page 27, lines 18-19).

Independent claim 14 recites an optical data recording medium, comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein a Young's modulus of the transparent substrate is smaller than 10.0×10^{9}(Pa), and the thin film layer is a single layered or multilayered film. In claim 14, at least either one of a linear expansion coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate, and the linear expansion coefficient of

the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C), and an expansion coefficient under humidity of the protective film is 1.7×10^{-4}(1/%) or smaller (see, e.g., page 27, lines 18-19).

Independent claim 18 recites a method of selecting a protective film in an optical data recording medium, the optical data recording medium comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein the transparent substrate has a Young's modulus smaller than 10.0×10^{9}(Pa), and wherein the thin film layer is a single layered or multilayered film including at least any one of a dielectric film, a recording film and a reflective film and the transparent substrate is made of a polycarbonate or a polyolefin with a thickness of 0.5 mm. The method includes the steps of:

determining the linear expansion coefficient of a material for making the protective film; and

selecting the material for making the protective film such that at least either one of a linear expansion coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate and the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C) (see, e.g., page 27, lines 18-19, and original claims 7 and 8).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection to be reviewed on appeal are:

(1) Whether claims 10-16 are unpatentable under 35 USC §102(b) over U.S. Patent No. 5,714,222 to Yokoyama et al. (hereinafter "Yokoyama").

(2) Whether claims 10-16 are unpatentable under 35 USC §102(b) over U.S. Patent No. 5,674,649 to Yoshioka et al. (hereinafter "Yoshioka").

(3) Whether claims 10-16 are unpatentable under 35 USC §102(b) over U.S. Patent No. 5,102,709 to Tachibana et al. (hereinafter "Tachibana").

(4) Whether claims 10-17 and 22 are unpatentable under 35 USC §103(a) over Tachibana.

(5) Whether claims 10-22 are unpatentable under 35 USC §103(a) over EP1031972 to Tajima et al. (hereinafter "Tajima").

ARGUMENT

1. Brief summary of argument

Three Section 102(b) rejections and two Section 103(a) rejections are outstanding in this case. The rejections cannot be sustained.

The cited documents do not disclose or otherwise suggest (explicitly or inherently) Appellant's claimed invention. In particular, the documents do not disclose optical recording media according to the pending claims, in which either one of a linear expansion coefficient and a Young's modulus of a protective film is greater than that of a transparent substrate, and the linear expansion coefficient of the protective film has a predetermined value.

The rejected claims do *not* stand or fall together since certain claims are considered separately patentable. Appellant submits that all of the claims under appeal are patentable including for reasons set forth below.

2. Examiner's position

The Examiner has stated that each of the Yokoyama, Yoshioka, Tachibana and Tajima references describes all the features of certain of the pending claims and/or renders obvious the pending claims. The Examiner concedes that the references do not explicitly describe optical media having the claimed properties, but the Examiner has taken the position that the references inherently disclose optical recording media having the properties of Appellant's claimed media.

For example, the Examiner states that "the position of the examiner is that the resins of the prior art inherently have the recited properties and is congruent with the specification of the applicant." See page 4 of the Final Office Action dated February 2, 2006.

3. Appellant's arguments

A. The cited documents do not disclose all the features of the claimed invention, explicitly or inherently.

The Yokoyama reference

The Yokoyama reference is directed to optical recording media having a protective layer or layers over a recording layer. According to Yokoyama, the protective layer is formed by spin-coating the protective layer over the substrate (see, e.g., the Abstract). The protective layer may be formed from epoxyacrylate resins or urethane acrylate resins. Yokoyama does not describe the expansion properties of any layer of the recited overcoating and more particularly does not teach or suggest controlling the warp or tilt of the optical recording media by modulating the linear expansion coefficient of one or more of the layers constituting the optical recording media.

The Yoshioka reference

The Yoshioka reference is directed to optical recording media having a recording layer which becomes amorphous with increased temperature and then melts and quenches by absorbing laser energy (see, e.g., Col. 2, lines 21-35). According to Yoshioka, the optical

recording medium optionally includes an "overcoat protective layer" (see, e.g., Col. 2, lines 50-52).

Yoshioka does not describe the expansion properties of any layer of the recited overcoating and more particularly does not teach or suggest controlling the warp or tilt of the optical recording media by modulating the linear expansion coefficient of one or more of the layers constituting the optical recording media. The Yoshioka reference does not expressly disclose any linear expansion coefficient for the protective coatings therein.

The Tachibana reference

The Tachibana reference is directed to optical recording media having a protective layer (see, e.g., Col. 2, lines 20-29). According to Tachibana, the protective layer or "resinous protective layer" can include a cured film of a photocurable resin including a polyfunctional acrylate compound and/or a urethane acrylate compound (see, e.g., Col. 2, lines 30-40). Tachibana does not describe the expansion properties of any layer of the recited overcoating and more particularly does not teach or suggest controlling the warp or tilt of the optical recording media by modulating the linear expansion coefficient of one or more of the layers constituting the optical recording media. The Tachibana reference does not expressly disclose any linear expansion coefficient for the protective coatings therein.

The Tajima Reference

The Tajima reference is directed to optical recording media in which the warpage caused by temperature changes is reduced (see, e.g., the Abstract).

At paragraphs [0035]-[0041], the Tajima reference discloses an example of an optical information recording medium made of three layers (a transparent substrate, a thin film layer, and a thin film protective coating). In this medium, the linear expansion coefficients and thicknesses of the transparent substrate and the thin film protective coat are adjusted to reduce the warp of the medium caused by temperature change.

B. The cited references neither anticipate nor render obvious the pending claims.

(i) **Rejections under 35 U.S.C. 102(b)**

(a) The Yokoyama reference

Claims 10-16 stand rejected over the Yokoyama reference. The rejection is traversed.

It is well-established that a claim is anticipated only if each and every element or feature of a claim is expressly or inherently described in a single prior art reference. See, e.g., MPEP 2131.

In the present case, the Examiner appears to agree that the Yokoyama reference does not expressly disclose all the elements of the presently-claimed invention. The Examiner nevertheless rejected the claims because "[t]he position of the Examiner is that the resins of the prior art inherently have the recited properties." Final Office Action at page 4.

Inherency, however, may not be established by probabilities or possibilities." MPEP 2112(IV), citing *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999) (citations omitted) (emphasis added).

The Examiner further states that "applicant argues that various polycarbonates are known and that the polycarbonates used by Yokoyama '222 are necessarily similar enough to those of the instant specification to have the recited properties." Appellants believe that this statement should read " . . . the polycarbonates used by Yokoyama '222 are <u>not</u> necessarily similar enough to those of the instant specification to have the recited properties;" the statement as originally quoted is not Appellants' position at all. Indeed, Appellants do consider that the materials disclosed by Yokoyama <u>do not necessarily</u> have the properties recited in the present claims, and therefore cannot anticipate the pending claims.

The Examiner also states that "urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims in the instant specification…" Final Office Action at page 3.

The Examiner appears to take the position that all urethane, epoxy, polyester and polyether acrylates which can be used in optical recording media inherently possess linear expansion coefficient and/or expansion coefficient under humidity and/or Young's modulus values specified in the pending claims.

Appellants respectfully contend that a mere assertion that a property is inherent is insufficient to prove that a reference is anticipatory. Although Appellants agree that certain urethane, epoxy, polyester or polyether acrylate materials are useful in the present invention, the pending claims further require that each material used in the protective layer or the transparent substrate possess specified values for the properties recited in the pending claims. Thus, the instant invention contemplates fabrication of the transparent substrate and protective layer from materials such as urethane, epoxy, polyester or polyether acrylate materials (or polyolefin or polycarbonate) which possess the requisite linear expansion coefficient and Young's modulus (e.g., as specified in independent claim 10 and claims dependent therefrom) or linear expansion coefficient, Young's modulus, and expansion coefficient under humidity (e.g., as specified in independent claim 14 and the claims dependent therefrom). While the Examiner states that "urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims," Appellants contend that the instant specification does not suggest that all polyester, epoxy, urethane or polyether acrylates are useful in the present invention. Rather, the present specification teaches that those materials meeting *specified limitations* of linear expansion coefficient, Young's modulus, and/or expansion coefficient under humidity, are useful in the claimed invention.

The claimed invention of claims 10-14 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C). The claimed invention of claims 14-16 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller

than 5.0×10^{-4} (1/°C) and an expansion coefficient under humidity of the protective film is 1.70×10^{-4} (1/%) or smaller. As disclosed by the present specification, optical data recording media which satisfy the above requirements are particularly resistant to deformation or warpage.

For a reference to inherently disclose a feature not expressly disclosed, extrinsic evidence can be used to supply the missing feature if the extrinsic evidence "make[s] clear that the missing descriptive matter is *necessarily present* in the thing described in the reference and that it would be so recognized by persons of ordinary skill in the art. However, the Examiner has not provided any extrinsic evidence that Yokoyama discloses *all the features* of the claimed invention.

The Yokoyama reference does not disclose materials having the characteristics of the claimed optical recording medium. Moreover, no extrinsic evidence has been presented to show or establish that the protective layers or transparent substrates of the optical recording media of Yokoyama <u>necessarily possess</u> the characteristics recited in claims 10 and 14 (and the claims dependent thereupon).

Appellants respectfully submit that the materials disclosed in the Yokoyama reference do not <u>necessarily possess</u> the properties of the claimed invention. Materials described in similar general terms can and often do have quite different properties, including different linear expansion coefficient, Young's modulus and/or expansion coefficient under humidity. It is clear that a reference disclosing a urethane acrylate, epoxy acrylate, or polyester or polyether acrylate would not <u>necessarily</u> provide a disclosure of a material having the claimed expansion coefficient under humidity.

(b) The Yoshioka reference

Claims 10-16 stand rejected over the Yoshioka reference. The rejection is traversed.

It is well-established that a claim is anticipated only if each and every element or feature of a claim is expressly or inherently described in a single prior art reference. See, e.g., MPEP 2131.

In the present case, the Examiner appears to agree that the Yoshioka reference does not expressly disclose all the elements of the presently-claimed invention. The Examiner refers to

Yoshioka as disclosing an optical recording medium "coated with a UV cured urethane-acrylate." Final Office Action at page 5. The Examiner rejected the claims over Yoshioka "for the reasons provided above [with respect to Yokoyama]." Final Office Action at page 5.

This rejection fails for at least the reason described above. As with the Yokoyama reference, the Examiner also states that "urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims in the instant specification..." Final Office Action at page 5.

The Examiner appears to take the position that all urethane, epoxy, polyester and polyether acrylates which can be used in optical recording media inherently possess linear expansion coefficient and/or expansion coefficient under humidity and/or Young's modulus values specified in the pending claims.

Appellants respectfully contend that a mere assertion that a property is inherent is insufficient to prove that a reference is anticipatory. While the Examiner states that "urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims," Appellants contend that the instant specification does not suggest that all polyester, epoxy, urethane or polyether acrylates are useful in the present invention. Rather, the present specification teaches that those materials meeting *specified limitations* of linear expansion coefficient, Young's modulus, and/or expansion coefficient under humidity, are useful in the claimed invention.

The claimed invention of claims 10-14 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C). The claimed invention of claims 14-16 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C) and an expansion coefficient under humidity of the protective film is 1.70×10^{-4} (1/%) or smaller. As disclosed by the present specification, optical data recording

media which satisfy the above requirements are particularly resistant to deformation or warpage.

For a reference to inherently disclose a feature not expressly disclosed, extrinsic evidence can be used to supply the missing feature if the extrinsic evidence "make[s] clear that the missing descriptive matter is *necessarily present* in the thing described in the reference and that it would be so recognized by persons of ordinary skill in the art. However, the Examiner has not provided any extrinsic evidence that Yoshioka discloses *all the features* of the claimed invention.

The Yoshioka reference does not disclose materials having the characteristics of the claimed optical recording medium. Moreover, no extrinsic evidence has been presented to show or establish that the protective layers or transparent substrates of the optical recording media of Yoshioka necessarily possess the characteristics recited in claims 10 and 14 (and the claims dependent thereupon).

Appellants respectfully submit that the materials disclosed in the Yoshioka reference do not necessarily possess the properties of the claimed invention. Materials described in similar general terms can and often do have quite different properties, including different linear expansion coefficient, Young's modulus and/or expansion coefficient under humidity. It is clear that a reference disclosing a urethane acrylate, epoxy acrylate, or polyester or polyether acrylate would not necessarily provide a disclosure of a material having the claimed expansion coefficient under humidity.

(c) The Tachibana reference

Claims 10-16 stand rejected over the Tachibana reference. The rejection is traversed.

It is well-established that a claim is anticipated only if each and every element or feature of a claim is expressly or inherently described in a single prior art reference. See, e.g., MPEP 2131.

In the present case, the Examiner appears to agree that the Tachibana reference does not expressly disclose all the elements of the presently-claimed invention. The Examiner refers to Tachibana as disclosing an optical recording medium "coated with a UV cured urethane-acrylate . . . ." Final Office Action at page 5. The Examiner rejected the claims over Tachibana "for the

reasons provided above [with respect to Tachibana]." Final Office Action at page 5.

This rejection fails for at least the reason described above. As with the Yokoyama and Yoshioka references, the Examiner also states that "urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims in the instant specification…" Final Office Action at page 6.

The Examiner appears to take the position that all urethane, epoxy, polyester and polyether acrylates which can be used in optical recording media inherently possess linear expansion coefficient and/or expansion coefficient under humidity and/or Young's modulus values specified in the pending claims.

Appellants respectfully contend that a mere assertion that a property is inherent is insufficient to prove that a reference is anticipatory. While the Examiner states that "urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims," Appellants contend that the instant specification does not suggest that all polyester, epoxy, urethane or polyether acrylates are useful in the present invention. Rather, the present specification teaches that those materials meeting *specified limitations* of linear expansion coefficient, Young's modulus, and/or expansion coefficient under humidity, are useful in the claimed invention.

The claimed invention of claims 10-14 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C). The claimed invention of claims 14-16 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C) and an expansion coefficient under humidity of the protective film is 1.70×10^{-4} (1/%) or smaller. As disclosed by the present specification, optical data recording media which satisfy the above requirements are particularly resistant to deformation or warpage.

For a reference to inherently disclose a feature not expressly disclosed, extrinsic evidence

can be used to supply the missing feature if the extrinsic evidence "make[s] clear that the missing descriptive matter is *necessarily present* in the thing described in the reference and that it would be so recognized by persons of ordinary skill in the art. However, the Examiner has not provided any extrinsic evidence that Tachibana discloses *all the features* of the claimed invention.

The Tachibana reference does not disclose materials having the characteristics of the claimed optical recording medium. Moreover, no extrinsic evidence has been presented to show or establish that the protective layers or transparent substrates of the optical recording media of Tachibana necessarily possess the characteristics recited in claims 10 and 14 (and the claims dependent thereupon).

Appellants respectfully submit that the materials disclosed in the Tachibana reference do not necessarily possess the properties of the claimed invention. Materials described in similar general terms can and often do have quite different properties, including different linear expansion coefficient, Young's modulus and/or expansion coefficient under humidity. It is clear that a reference disclosing a urethane acrylate, epoxy acrylate, or polyester or polyether acrylate would not necessarily provide a disclosure of a material having the claimed expansion coefficient under humidity.

Like the references discussed above, the Tachibana reference does not expressly disclose *any* linear expansion coefficient for the protective coatings therein, let alone a linear expansion coefficient of the protective film in the range recited in the present claims, and there is no teaching that the materials necessarily possess all the properties recited in the pending claims.

Moreover, although the Examiner states that the Tachibana reference discloses that certain media have a certain warpage after durability testing, the warpage data disclosed in the Tachibana patent do not demonstrate that the optical recording media there disclosed meet the limitations of the present claims. The warp of exhibited by a particular recording medium is the result of a variety of factors, and the Examiner has not demonstrated that the observed warpage results of Tachibana are the result of, e.g., the substrate and protective film of Tachibana meeting the limitations of the present claims.

(ii) **Rejections under 35 U.S.C. 103(a)**

(a) The Tachibana reference

Claims 10-17 and 22 stand rejected over the Tachibana reference. The rejection is traversed.

The teachings of the Tachibana reference, and the differences between Tachibana and independent claims 10 and 14, have been discussed above. Appellants contend that claims 10 and 14, and the claims dependent therefrom, are not obvious in view of Tachibana for at least the reasons discussed above. As discussed above, Appellants contend that Tachibana does not disclose media having the specified properties of the pending claims. In view of the *silence* of Tachibana as to these properties, Appellants respectfully urge that it would not have been obvious to one of ordinary skill to modify the teachings of Tachibana to arrive at the claimed invention. Tachibana cannot teach or suggest materials having properties that Tachibana does not even describe. Because Tachibana does not expressly disclose the properties of the materials as recited in the pending claims, there could not be any motivation to modify the teachings of Tachibana as suggested by the Examiner to arrive at the claimed invention.

Moreover, the invention of claim 22 is directed to an optical data recording medium provided with a protective film for protecting a thin film layer selected by the method of any one of claims 18 to 21. The Examiner has not even asserted that Tachibana anticipates or renders obvious any of claims 18 to 21 (as indeed it does not). Tachibana does not disclose or render obvious a method as recited in any of claims 18-21. Appellants submit that claim 22 cannot be rendered obvious by Tachibana.

(b) The Tajima reference

Claims 10-22 stand rejected over the Tajima reference. The rejection is traversed.

The Examiner describes the Tajima reference as disclosing "optimization of linear expansion coefficient, thickness and Young's modulus of the protective layer to offset the stresses on either side of the dielectric layer due to the substrate to reduce warpage," Final

Office Action at page 7, but the Examiner apparently agrees that Tajima does not disclose materials having the linear expansion coefficients recited in the pending claims. However, the Examiner states that "[I]t would have been obvious to one skilled in the art to modify the example [of Tajima] by doubling the linear expansion coefficient . . . and decreasing the thickness nearly by half to . . . maintain the same force on the side of the medium opposite the side of the substrate." Final Office Action at page 7. Appellants cannot agree with these statements.

The Examiner further states that "the examiner holds that the last layer to be coated/formed would be the obvious choice for optimization . . . by choosing resins compositions which have higher linear expansion coefficients." Final Office Action at page 8.

However, as the Examiner seems to acknowledge, the linear coefficient of expansion of the protective film of the present invention is different from, and greater than, the linear expansion coefficient disclosed in Tajima (EP1031972) (see, e.g., Table 1 of Tajima (EP1031972)).

The claimed invention of claims 10-14 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C). The claimed invention of claims 14-16 provides that the material of the protective film has at least one of a linear expansion coefficient and a Young's modulus value greater than that of the transparent substrate and that the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C) and an expansion coefficient under humidity of the protective film is 1.70×10^{-4} (1/%) or smaller. As disclosed by the present specification, optical data recording media which satisfy the above requirements are particularly resistant to deformation or warpage. Claim 18 (and the claims dependent therefrom) is directed to a method of selecting a protective film in an optical data recording medium, the optical data recording medium comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective

film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein the transparent substrate has a Young's modulus smaller than 10.0×10^9(Pa), and wherein the thin film layer is a single layered or multilayered film including at least any one of a dielectric film, a recording film and a reflective film and the transparent substrate is made of a polycarbonate or a polyolefin with a thickness of 0.5 mm. The method includes the steps of:

determining the linear expansion coefficient of a material for making the protective film; and

selecting the material for making the protective film such that at least either one of a linear expansion coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate and the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C).

Appellants respectfully contend that the Examiner's proposed modification of the Tajima reference appears to rely on hindsight; that is, the Examiner's view of the Tajima reference is colored by the teachings of the instant specification. The Examiner appears to be using the teachings of the present invention as a road-map to modify the teachings of the prior art to thereby arrive at the presently-claimed invention. This is an improper hindsight rejection; see, e.g., *Grain Processing Corp. v. American Maize-Prods. Co.*, 840 F.2d 902, 907, 5 USPQ2d 1788, 1792 (Fed. Cir. 1988). Appellants respectfully contend that, prior to the present invention, one of ordinary skill in the art would not have been motivated to make the modifications suggested by the Examiner.

Moreover, one of ordinary skill in the art would not have had a reasonable expectation of success in making the modification to the teachings of Tajima as suggested by the Examiner. The Examiner has not pointed to any teaching in Tajima (or anywhere else) of materials having all the properties (and relationships among properties of the various components) recited in the pending claims. Prior to the present invention, one of ordinary skill in the art would not have had a reasonable expectation of success in making the modification to the teachings of Tajima as suggested by the Examiner. For this reason, too, the claims are not obvious in view of Tajima.

C. Comparative data effectively rebuts any *prima facie* case of anticipation that may be contended to exist

Moreover, while Appellant fully believes that a *prima facie* case of anticipation under 35 U.S.C. 102(b) or obviousness under 35 U.S.C. 103(a) has not been made by the Examiner, it is also believed that previously-presented test data fully rebuts any *prima facie* case that may be contended to exist.

As Appellants pointed out in the "Preliminary Amendment (Filed With Request for Continued Examination)" filed on March 22, 2005 (a copy of the pertinent part of which is attached hereto as Exhibit E), materials described in similar general terms can and often do have quite different properties, including different linear expansion coefficients. For example, as shown on the attached Table (also reproduced at Exhibit E), materials generically termed "acrylic UV curable resins" having similar principal components can nevertheless have a range of linear expansion coefficients (in the Table, ranging from about 1.10×10^{-5} to about 1.46×10^{-4} (l/°C) (note that the acrylic ester commercial product listed at the bottom of the Table does not have a linear expansion coefficient within the range required by the instant claims). It is clear that a reference disclosing an acrylic UV curable resin would not <u>necessarily</u> provide a disclosure of an acrylic UV curable resin having a linear expansion coefficient *in a specific range.*

The Examiner has suggested that "direct comparison with the prior art" could obviate the rejections of record. Appellants note that certain resins disclosed in the cited references are apparently no longer produced. For example, Appellants also note that, contrary to the Examiner's suggestion that the resin "SD101 appears to be still available," Final Office Action at page 5, it is believed that this material is no longer sold.

In the "Response to Non-final Office Action" dated January 26, 2006 (a copy of the pertinent part of which is attached hereto at Exhibit F), Appellants provided the following data and remarks:

The resin composition disclosed in Example 3 of Tachibana (KAYARAD DPCA-30 (70%), KAYARAD R-604 (25%), IRG-184, 5%) has a linear expansion coefficient of 9.0 x 10^{-5} (1/°C). This linear expansion coefficient is not within the range of values of the linear expansion coefficient recited by the pending claims (greater than 9.5×10^{-5} (1/°C) and smaller than 5.0 $\times 10^{-4}$(1/°C)). Thus, this composition does not in fact possess the properties of the claimed invention, and cannot anticipate the pending claims. There is no teaching or suggestion in Tachibana that this resin or any other materials disclosed therein necessarily possess all the properties recited in the pending claims.

Appellants contend that this experiment provides additional support for Appellants' contention that the cited references do not necessarily disclose materials for optical data recording media having the properties of the claimed media. Appellants therefore contend that the inherency rejection cannot be maintained.

In the Final Office Action, the Examiner stated that "there is no basis for why this [data] could possibly be a better comparison than one with the cited example." Final Office Action at page 6. However, the data described above establish that the Examiner's primary premise – that "[in the cited references] urethane, epoxy, polyester and polyether acrylates are disclosed as useful and meeting the material limitation of the claims" – is flawed, and that the cited references (not only Tachibana) therefore cannot inherently disclose materials meeting the limitations of the pending claims. Appellants have provided counter-examples which demonstrate that the Examiner's position on inherency is unsound. See, e.g., MPEP 2112(V).

In summary, the cited references do not teach or suggest optical recording media of the present claims which are resistant to deformation or warpage. None of the references teaches or suggests that the materials used in the fabrication of the optical recording media should be selected to have the claimed properties.

D. The remaining claims on appeal are separately patentable

The cited references also provides no disclosure of other aspects of Appellant's claimed

invention.

a) Claim 11

Claim 11 is separately patentable for the above-stated reasons and further because the cited references fail to teach or suggest the optical recording medium of claim 10 wherein an expansion coefficient under humidity (ratio of expansion (1/%) where a difference of relative humidity (vapor content/ saturated vapor amount at 25°C) is increased by 1%) of the protective film is 1.7×10^{-4}(1/%) or smaller. The cited references do not teach or suggest this feature of claim 11.

b) Claims 12 and 13

Claims 12 and 13 are separately patentable for the above-stated reasons and further because the cited references fail to teach or suggest the optical recording medium of claim 10 (or 11) wherein the Young's modulus of the transparent substrate is smaller than 10.0×10^{9}(Pa). The cited references do not teach or suggest this feature of claims 12 and 13.

c) Claim 19

Claim 19 is separately patentable for the above-stated reasons and further because the cited references fail to teach or suggest the method of selecting a protective film in an optical data recording medium according to claim 18 wherein the protective film is selected such that the Young's modulus of the protective film is greater than 2.0×10^{9}(Pa) and smaller than 1.0×10^{10}(Pa). The cited references do not teach or suggest this feature of claim 19.

c) Claims 20 and 21

Claims 20 and 21 are separately patentable for the above-stated reasons and further because the cited references fail to teach or suggest the method of selecting a protective film in an optical data recording medium according to claim 18 (or 19) wherein the protective film is selected such that an expansion coefficient under humidity thereof (ratio of expansion

(1/%) where a difference of relative humidity (vapor content/saturated vapor amount at 25°C) is increased by 1%) of the protective film is 1.7×10^{-4}(1/%) or smaller. The cited references do not teach or suggest this feature of claims 20 and 21.

SUMMARY

Appellants submit that all of the claims under final rejection are in condition for allowance and should be allowed, and that the Final Office Action should be vacated.

If for any reason a fee is required, a fee paid is inadequate or credit is owed for any excess fee paid, you are hereby authorized and requested to charge Deposit Account No. **04-1105**, under Reference No. 56702 (70801), Customer No. 21874.

Respectfully submitted,

Date: December 4, 2006

By: ______________________

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CLAIMS APPENDIX

1-9. (Cancelled).

10. An optical data recording medium comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein the thin film layer is a single layered or multilayered film including at least any one of a dielectric film, a recording film and a reflective film, and at least either one of a linear expansion coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate, and the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4}(1/°C).

11. An optical data recording medium according to claim 10, wherein an expansion coefficient under humidity (ratio of expansion (1/%) where a difference of relative humidity (vapor content/ saturated vapor amount at 25°C) is increased by 1%) of the protective film is 1.7×10^{-4}(1/%) or smaller.

12. An optical data recording medium according to claim 10, wherein the Young's modulus of the transparent substrate is smaller than 10.0×10^{9}(Pa).

13. An optical data recording medium according to claim 11, wherein the Young's modulus of the transparent substrate is smaller than 10.0×10^{9}(Pa).

14. An optical data recording medium, comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein a Young's modulus of the transparent substrate is smaller than 10.0×10^{9}(Pa), and the thin film layer is a single layered or multilayered film, and wherein at least either one of a linear expansion

coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate, and the linear expansion coefficient of the protective film is greater than 9.5×10^{-5} (l/°C) and smaller than 5.0×10^{-4} (1/°C), and an expansion coefficient under humidity of the protective film is 1.7×10^{-4}(1/%) or smaller.

15. An optical data recording medium according to any one of claims 10 to 14, wherein a thickness of the protective film is 5 μm or more to 20 μm or less.

16. An optical data recording medium according to any one of claims 10 to 14, wherein the protective film is made of an ultraviolet light curing resin.

17. An optical data recording medium according to any one of claims 10 to 14, wherein the transparent substrate is made of a polycarbonate or a polyolefin and a thickness thereof is about 0.5 mm.

18. A method of selecting a protective film in an optical data recording medium, the optical data recording medium comprising a transparent substrate, a thin film layer formed on the transparent substrate and a protective film which is mainly comprised of a resin and formed on the thin film layer for protecting the thin film layer, wherein the transparent substrate has a Young's modulus smaller than 10.0×10^{9}(Pa), and wherein the thin film layer is a single layered or multilayered film including at least any one of a dielectric film, a recording film and a reflective film and the transparent substrate is made of a polycarbonate or a polyolefin with a thickness of 0.5 mm, the method comprising the steps of:

determining the linear expansion coefficient of a material for making the protective film; and

selecting the material for making the protective film such that at least either one of a linear expansion coefficient and a Young's modulus of the protective film is greater than that of the transparent substrate and the linear expansion coefficient of the protective film is

greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4} (1/°C).

19. A method of selecting a protective film in an optical data recording medium according to claim 18, wherein the protective film is selected such that the Young's modulus of the protective film is greater than 2.0×10^{9}(Pa) and smaller than 1.0×10^{10}(Pa).

20. A method of selecting a protective film in an optical data recording medium according to claim 18, wherein the protective film is selected such that an expansion coefficient under humidity thereof (ratio of expansion (1/%) where a difference of relative humidity (vapor content/saturated vapor amount at 25°C) is increased by 1%) of the protective film is 1.7×10^{-4}(1/%) or smaller.

21. A method of selecting a protective film in an optical data recording medium according to claim 19, wherein the protective film is selected such that an expansion coefficient under humidity thereof (ratio of expansion (1/%) where a difference of relative humidity (vapor content/saturated vapor amount at 25°C) is increased by 1%) of the protective film is 1.7×10^{-4}(1/%) or smaller.

22. An optical data recording medium provided with a protective film for protecting a thin film layer selected by the method of any one of claims 18 to 21.

EVIDENCE APPENDIX

Tab A Copy of U.S. Patent No. 5,714,222 to Yokoyama et al. ("Yokoyama"), as relied on by the Examiner in the Final Office Action of 02/02/2006.

Tab B Copy of U.S. Patent No. 5,674,649 to Yoshioka et al.("Yoshioka "), as relied on by the Examiner in the Final Office Action of 02/02/2006.

Tab C Copy of U.S. Patent No. 5,102,709 to Tachibana et al. ("Tachibana "), as relied on by the Examiner in the Final Office Action of 02/02/2006.

Tab D Copy of EP 1031972 to Tajima et al. ("Tajima "), as relied on by the Examiner in the Final Office Action of 02/02/2006.

Tab E Portion of "Preliminary Amendment (Filed With Request for Continued Examination)" as filed by Appellants, dated March 22, 2005.

Tab F Portion of "Response to Non-final Office Action" as filed by Appellants, dated January 26, 2006.

RELATED PROCEEDINGS APPENDIX

None.

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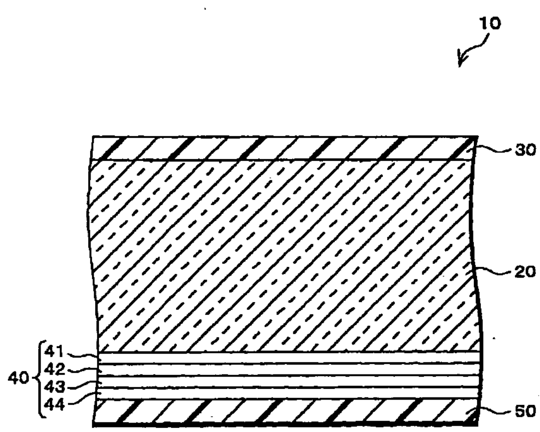
(54) Optical information recording medium

(57) An optical information recording medium includes a transparent substrate, a thin film layer formed on said transparent substrate and having a recording film, a thin film protecting film formed on said thin film layer, and a substrate protecting film formed on said transparent substrate. A neutral plane of deformation caused by a temperature change of the optical information recording medium is present within the thin film layer. Consequently, it has become possible to provide an optical information recording medium which can prevent deformation (warpage) caused by temperature and humidity changes and be readily manufactured.

F I G. 1



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to an optical information recording medium for recording and reproducing information, and more particularly, to an optical information recording medium which can suppress warpage caused by a change in environments or variance with time.

BACKGROUND OF THE INVENTION

[0002] As an example optical information recording medium for recording and reproducing information, a thin disk type has been known. Figure 6(a) is a plan view of such an optical information recording medium and Figure 6(b) is a side elevation thereof.

[0003] Figure 7 is a schematic cross section showing an arrangement of a conventional optical information recording medium 110.

[0004] As shown in Figure 7, the conventional optical information recording medium 110 includes a disk (see Figure 6(a)) substrate 120 made of polycarbonate or the like, on which a single- or multi-layer thin film layer 140 comprising thin films, such as dielectric films 141 and 143 (silicon nitride, etc.), a recording film 142 (TbFeCo, etc.), and a reflecting film 144 (Al, etc.), is formed by means of sputtering or the like.

[0005] Also, a thin film protecting film 150 made of a resin film or the like is formed on the thin film layer 140, and a substrate protecting film 130 made of resin or the like is formed on the light incident surface of the substrate 120.

[0006] The thicknesses of these films and layers are as follows: the thickness of the substrate 120 is approximately 1.2 mm; the thickness of the single- or multi-layer thin film layer 140 formed by means of sputtering or the like is 10-30 nm; the thickness of the thin film protecting film 150 is 1-30 μm; and the thickness of the substrate protecting film 130 is 1-30 μm. Thus, the substrate 120 made of polycarbonate occupies most of the optical information recording medium 110 in thickness.

[0007] The rigidity of the optical information recording medium 110 depends almost entirely on the substrate 120, and because the substrate 120 is sufficiently thick, deformation caused by a change in environments (temperature and humidity changes) is quite small. For this reason, a balance of stress and a bending moment of each layer has not been considered generally in most of the cases.

[0008] However, there has been a demand to further increase recording and reproducing density of the optical information recording medium, and the substrate has been made thinner (for example, the thickness is now reduced to 0.6 mm from 1.2 mm) to suppress the occurrence of aberration. As a result, the rigidity of the optical information recording medium is reduced, and larger deformation occurs due to stress produced in each layer forming the optical information recording medium with a change in environments (temperature and humidity changes), thereby posing a problem that information can not be readily recorded and reproduced. Thus, there has been an increasing need for an optical information recording medium which can maintain good performance in response to a change in environments even if its rigidity is reduced by employing a thinner substrate.

[0009] Japanese Laid-open Patent Application No. 195745/1992 (Japanese Official Gazette, *Tokukaihei No. 4-195745*, published on July 15, 1992) discloses a technique of suppressing deformation of the optical information recording medium, by which a warpage preventing dielectric film is provided on the back surface (the surface on which the thin film layer is not formed) of the substrate (prior art ①).

[0010] Figure 8 is a cross section showing an arrangement of the above optical information recording medium (prior art ①). In Figure 8, like components are labeled with like reference numerals with respect to Figure 7 for ease of explanation. As shown in Figure 8, a dielectric layer 160 is provided on the light incident side of the substrate 120 made of polycarbonate, so that the same expansion coefficient is given to the recording film 142 and dielectric layer 160 which are provided respectively at the both sides of the transparent substrate 120. Consequently, because the optical information recording medium has a symmetrical structure with respect to the substrate 120, warpage of the optical information recording medium can be prevented.

[0011] Also, Japanese Laid-open Patent Application No. 64119/1998 (Japanese Official Gazette, *Tokukaihei No. 10-64119*, published on March 6, 1998) discloses that, by making a thin film protecting film thicker (30-50 μm), warpage occurring with increasing temperatures can be prevented (prior art ②).

[0012] Further, Japanese Laid-open Patent Application No. 364248/1992 (Japanese Official Gazette, *Tokukaihei No. 4-364248*, published on December 16, 1992) proposes an optical information recording medium which can solve problematic warpage caused by a humidity change. This optical information recording medium includes, as shown in Figure 9, a thin film protecting film 150, a thin film layer 140, a substrate 120, a substrate protecting film 130, and in order to solve the problem, it additionally includes a moisture permeation preventing film 170 made of SiO_2, AlN, etc. between the substrate 120 and substrate protecting film 130 (prior art ③). In Figure 9, like components are labeled with

like reference numerals with respect to Figures 7 and 8 for ease of explanation.

[0013] However, according to the technique disclosed in Japanese Laid-open Patent Application No. 195745/1992 *supra* (see Figure 8, prior art ①), the dielectric layer 160 has to be provided on the light incident side of the substrate 120 by means of sputtering or the like. In this case, the manufacturing procedure includes forming the thin film layer 140 on one surface of the substrate 120, turning over the substrate 120, and forming the dielectric layer 160 on the opposite surface. Thus, not only the manufacturing procedure becomes complex, but also expensive manufacturing facility is required, thereby posing a problem that the manufacturing costs are undesirably increased.

[0014] Also, the technique (prior art ②) of Japanese Laid-open Patent Application No. 64119/1998 *supra* poses a problem that the thin film protecting film is so thick that it can not be readily formed. In addition, in case that the optical information recording medium is a magneto-optical recording medium, for example, in order to turn an applied magnetic field inversely at a high speed while information is being recorded, it is preferable to approximate the thin film layer to magnetic field generating means. However, a too thick thin film protecting film can cause problematic deterioration of magnetic characteristics.

[0015] Further, the technique of Japanese Laid-open Patent Application No. 364248/1992 *supra* (see Figure 9, prior art ③) demands the moisture permeation preventing film 170 made of SiO_2, AlN, etc. to be provided on the light incident side of the substrate 120 by means of sputtering or the like. In this case, the manufacturing procedure includes forming the thin film layer 140 on one surface of the substrate 120, turning over the substrate 120, and forming the moisture permeation preventing film 170 on the opposite surface. Thus, not only the manufacturing procedure becomes complex, but also expensive manufacturing facility is required, thereby posing a problem that the manufacturing costs are undesirably increased.

SUMMARY OF THE INVENTION

[0016] It is therefore an object of the present invention to provide an optical information recording medium which can prevent deformation (warpage) caused by temperature and humidity changes and be readily manufactured.

[0017] In order to fulfill the above and other objects, an optical information recording medium of the present invention is characterized by being furnished with:

a thin film layer, formed on a substrate, for recording and reproducing information; and
a thin film protecting film, formed on the thin film layer, for protecting the thin film layer,
a neutral plane of deformation in a thickness direction caused by a temperature change being present in a vicinity of the thin film layer.

[0018] According to the above arrangement, the optical information recording medium has a multi-layer structure in which the thin film layer and thin film protecting film are formed on the substrate.

[0019] If the substrate is made thinner in the optical information recording medium having such a multi-layer structure, the rigidity is reduced, thereby posing a problem that warpage occurs in the thickness direction toward the thin film protecting film in response to a temperature change.

[0020] To solve the above problem, a conventional optical information recording medium employing a thin substrate is additionally provided with a warpage preventing dielectric layer. This solution, however, raises another problem that, by providing the additional layer, the number of manufacturing steps and manufacturing costs are undesirably increased. In particular, because the dielectric layer is formed on the opposite side (the side opposite to the side where the thin film layer is formed) of the substrate, the substrate has to be turned over after the thin film layer is formed. Accordingly, not only the manufacturing procedure becomes complex, but also expensive manufacturing facility is required, thereby increasing the manufacturing costs.

[0021] In contrast, according to the arrangement of the present invention, the neutral plane of deformation in the thickness direction caused by a temperature change is present in the vicinity of the thin film layer. In other words, bending moments applied on the thin film layer from the substrate side and thin film protecting film side are substantially cancelled out with each other.

[0022] More specifically, warpage of the optical information recording medium in the direction toward the thin film protecting film is caused by a bending moment applied on the thin film layer from the substrate side. Thus, according to the arrangement of the present invention, the bending moment applied on the thin film layer from the substrate side is cancelled out with a bending moment applied thereon from the thin film protecting film side, and the vicinity of the thin film layer serves as the neutral plane of deformation in the thickness direction. Hence, the optical information recording medium of the present invention causes warpage neither in the thickness direction nor in the opposite direction.

[0023] Consequently, different from the conventional arrangement, the additional warpage preventing dielectric layer can be omitted, thereby eliminating the problem that the manufacturing procedure becomes complex and the manufacturing costs are increased.

[0024] In order to fulfill the above and other objects, another optical information recording medium of the present invention is characterized by being furnished with:

a thin film layer, formed on a substrate, for recording and reproducing information;
a thin film protecting film, formed on the thin film layer, for protecting the thin film layer; and
a substrate protecting film, formed on the substrate on a surface opposite to a surface where the thin film layer is formed, for protecting the substrate,
a moisture permeation degree of the substrate protecting film being smaller than a moisture permeation degree of the thin film protecting film.

[0025] In case of the optical information recording medium in which the thin film layer and thin film layer protecting film are formed on one side of the substrate and the substrate protecting film on the other side, only a slight quantity of water is absorbed from the external and reaches the substrate in the thin film protecting film side because of the thin film layer interposed therebetween, whereas water readily reaches the substrate in the substrate protecting film side. Thus, there is a problem that a volume change occurs locally on the substrate in response to a humidity change, thereby causing warpage of the optical information recording medium.
[0026] In order to solve such a problem, a conventional optical information recording medium is additionally provided with a moisture permeation preventing film which can prevent warpage caused by a humidity change. This solution, however, raises another problem that, by providing the additional layer, the number of manufacturing steps and manufacturing costs are undesirably increased. In particular, because the moisture permeation preventing film is provided between the substrate and substrate protecting film, the substrate has to be turned over after the thin film layer is formed. Accordingly, not only the manufacturing procedure becomes complex, but also expensive manufacturing facility is required, thereby increasing the manufacturing costs.
[0027] In contrast, according to the arrangement of the present invention, a moisture permeation degree of the substrate protecting film is smaller than that of the thin film protecting film. Hence, because absorption of water from the substrate protecting film side can be reduced, warpage of the optical information recording medium caused by a humidity change can be suppressed.
[0028] Consequently, different from the conventional arrangement, the additional moisture permeation preventing film can be omitted, thereby eliminating the problem that the manufacturing procedure becomes complex and the manufacturing costs are increased.
[0029] For a fuller understanding of the nature and advantages of the invention, reference should be made to the ensuing detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Figure 1 is a schematic cross section showing an arrangement of an optical information recording medium in accordance with an embodiment of the present invention;
Figures 2(a) and 2(b) are views explaining warpage of the optical information recording medium;
Figure 3 is a view explaining a multi-layer beam;
Figure 4 is a view showing time dependency of a variation of warpage angles in response to a temperature change;
Figure 5 is a view showing time dependency of a variation of warpage angles in response to a humidity change;
Figure 6(a) is a plan view showing an arrangement of a typical optical information recording medium, and Figure 6(b) is a side elevation thereof;
Figure 7 is a schematic cross section showing an arrangement of a conventional optical information recording medium;
Figure 8 is a schematic cross section showing an example of a conventional optical information recording medium;
Figure 9 is a schematic cross section showing another example of a conventional optical information recording medium;
Figure 10 is a view showing time dependency of a variation of warpage angles in response to a temperature change in an optical information recording medium as one example of the present invention; and
Figure 11 is a view showing time dependency of a variation of warpage angles in response to a humidity change in an optical information recording medium as one example of the present invention.

DESCRIPTION OF THE EMBODIMENTS

(Embodiment 1)

[0031] The following will explain an optical information recording medium of the present embodiment, and the principle of the present invention will be given in the first place.

① Principle

[0032] As has been discussed in the BACKGROUND OF THE INVENTION, the optical information recording medium disclosed in Japanese Laid-open Patent Application No. 195745/1992 *supra* (see Figure 8) suppresses warpage of the optical information recording medium by forming the layers symmetrically with respect to the transparent substrate 120.

[0033] In this regard, with an optical information recording medium 10 including, as shown in the schematic cross section of Figure 1, a thin film protecting film 50, a thin film layer 40, a transparent substrate (substrate) 20, and a substrate protecting film 30, the inventors of the present invention discovered that (a) warpage of the optical information recording medium 10 can be suppressed by positioning the thin film layer 40 (or the vicinity thereof) at the center of deformation caused by a temperature change, that is, making the optical information recording medium 10 symmetrical with respect to the thin film layer 40, and (b) the thin film protecting film 50 can be made thinner while warpage is suppressed. This will be described more in detail in the following.

[0034] As shown in Figure 1, the optical information recording medium 10 includes the transparent substrate 20 made of polycarbonate or the like, on which the single-or multi-layer thin film layer 40 comprising thin films, such as dielectric films 41 and 43 (silicon nitride, etc.), a recording film 42 (TbFeCo, etc.), and a reflecting film 44 (Al, etc.), is formed by means of sputtering or the like. In addition, the thin film protecting film 50 mainly made of resin is formed on the thin film layer 40, and the substrate protecting film 30 mainly made of resin is formed on the transparent substrate 20 on the opposite surface to the surface where the thin film layer 40 is formed, so that the transparent substrate 20 is protected.

[0035] As has been discussed, the optical information recording medium is generally composed of multiple layers, and because each layer has different linear expansion coefficient as one of the physical properties, stress produced in each layer in response to a temperature change is also different.

[0036] To be more specific, the transparent substrate 20 made of polycarbonate, substrate protecting film 30, and thin film protecting film 50 normally have larger linear expansion coefficients than the thin film layer 40, and expansion of the thin film layer 40 in the radius direction of the substrate is quite small compared with that of the other layers. Also, the thickness of the transparent substrate 20 is quite large compared with the thicknesses of the substrate protecting film 30 and thin film protecting film 50, and each thin film forming the thin film layer 40 has quite large Young's modulus compared with the other layers. Thus, in response to a temperature change, the thin film layer 40 expands slightly while the transparent substrate 20 expands significantly. As a result, the optical information recording medium 10 readily causes warpage in a direction perpendicular to the radius direction toward the thin film protecting film 50 in the film thickness direction. Figure 2(a) is a plan view schematically explaining warpage, and Figure 2(b) is a side elevation thereof.

[0037] In the present embodiment, in order to prevent such warpage, a bending moment is applied to the thin film layer 40 in the opposite direction to a bending moment applied thereto from the transparent substrate 20 by adjusting the linear expansion coefficient, Young's modulus, and film thickness of the thin film protecting film 50 formed on the thin film layer 40. Then, by using a plane parallel to the film surface within the thin film layer 40 (or in the vicinity thereof) as a neutral plane of deformation, deformation (warpage shown in Figures 2(a) and 2(b)) caused by a temperature change can be suppressed.

[0038] To be more specific, the optical information recording medium 10 of the present invention is arranged in such a manner that a neutral plane of deformation in the thickness direction caused by a temperature change is present in the vicinity of the thin film layer 40. In other words, the optical information recording medium 10 of the present invention is arranged in such a manner that bending moments applied on the thin film layer 40 from the substrate 20 side and thin film protecting film 50 side in response to a temperature change are substantially cancelled out with each other.

[0039] In order to realize such an arrangement, the thickness, Young's modulus, linear expansion coefficient of each of the substrate 20, thin film layer 40, and the thin film protecting film 50 (particularly the thin film protecting film 50) are set to their respective desired values.

[0040] The linear expansion coefficient, Young's modulus, film thickness of the thin film protecting film 50 are set in accordance with the approximate calculations set forth below.

[0041] In the optical information recording medium 10, three kinds of stress are produced in response to a temperature change: stress (axial tension) applied in the radius direction; stress applied in a circumferential direction; and

stress applied in the film thickness direction. However, because the optical information recording medium 10 is a disk, the stress applied in the circumferential direction is even within the circumference, and a force in the film thickness direction is applied evenly within each layer. Therefore, these two kinds of stress can be assumed as non-contributing factors to deformation. Hence, deformation, that is, warpage (see Figures 2(a) and 2 (b)), of the optical information recording medium 10 can be replaced with warpage in a multi-layer beam which corresponds to the cross section of the same. Figure 3 shows the multi-layer beam, in which n-layer beam are illustrated, where n represents the number of layers in the optical information recording medium. In case of the optical information recording medium 10 of Figure 1, n=7.

[0042] Warpage angles θ in the multi-layer beam in response to a temperature change can be expressed by following Equations (1) through (5) derived from a balance of the axial tension P_i (i=1, 2, ..., n) and bending moment M_i in each layer:

$$M_i = E_i I_i / R_i \tag{1}$$

$$\alpha_i T + (P_i / bt_i E_i) - (t_i / 2R_i) = \alpha_{i+1} T + (P_{i+1} / bt_{i+1} E_{i+1}) + (t_{i+1} / 2R_{i+1}) \tag{2}$$

$$\sum_{i=1}^{n} P_i = 0 \tag{3}$$

$$\sum_{i=1}^{n} M_i + P_1\{y-(t_1/2)\} + P_2\{y-t_1-(t_2/2)\} + \cdots + P_n\{y-t_1-t_2-\cdots-(t_n/2)\} = 0 \tag{4}$$

$$\theta = \tan^{-1}((L-2)/R \tag{5}$$

where

α_i: linear expansion coefficient of the i layer
E_i: Young's modulus of the i layer
t_i: thickness of the i layer
P_i: axial tension in the i layer
M_i: bending moment in the i layer
R_i: radius of curvature
I_i: secondary moment of the i layer's cross section
b: width of multi-layer beam (unit length)
T: temperature change
L: length of a beam
y: neutral plane's position in the n-layer beam
θ: warpage angles (see Figure 3) at the largest variation part when a length l=4 mm.

[0043] Because the thickness of each layer is far smaller than the radius of curvature, the radius of curvature (R_i) in each layer (i=1, 2, • • •, n) can be deemed as equal (R_1=R_2=R_3= • • • =R). Also, a temperature change (T) is a temperature change in the usable temperature environment (generally, from -15°C to 80°C) of the optical information recording medium.

[0044] In Equations (1) through (5) above, the thickness, linear expansion coefficient (a), and Young's modulus (E) of each layer (particularly those of the thin film protecting film 50, because those of the thin film layer 40 are often determined in advance by characteristics of the optical information recording medium) are determined in such a manner that, when y is set within the thin film layer 40, small θ is given, that is, a large radius of curvature (R) is given. Consequently, an optical information recording medium which can suppress warpage shown in Figures 2(a) and 2(b) caused by a temperature change can be obtained.

[0045] Incidentally, when the thin film protecting film 50 in the optical information recording medium becomes thicker, it becomes more difficult to form the same by means of spin coating. Also, in case that the optical information recording medium is a magneto-optical recording medium, if the thin film protecting film 50 becomes thicker, the magnetic head is spaced apart farther from the thin film layer 40, which is not preferable from the view points of magnetic characteristics. In view of the foregoing, the film thickness of the thin film protecting film 50 is preferably set to 30 μm or less, and more preferably to 20 μm or less. Thus, the thin film protecting film 50 has to satisfy the above film thickness

condition (30 μm or less (preferably 20 μm or less)), and at the same time it has to be made of materials having the linear expansion coefficient (α) and Young's modulus (E) such that can reduce θ in Equations (1) through (5) above. According to Equations (1) through (5) above, even if the film thickness is small, θ can be reduced by making at least one of the linear expansion coefficient (α) and Young's modulus (E) large.

[0046] As has been discussed, with the optical information recording medium 10 of the present embodiment, the occurrence of warpage can be suppressed by setting the physical properties of each layer (particularly the thin film protecting film 50) in such a manner that the neutral plane of deformation caused by a temperature change is positioned within (or in the vicinity of) the thin film layer 40. In addition, of all the layers forming the optical information recording medium 10, the thin film layer 40 having the slowest deformation rate causes the slightest deformation, and overshoot of variation, which causes a problem when a temperature actually changes, also becomes small. Further, because only the substrate protecting film 30 mainly made of resin has to be formed on the light incident side of the transparent substrate 20, the optical information recording medium 10 can be manufactured more readily in comparison with the spin coating or the like, thereby simplifying the manufacturing procedure.

[0047] The above description explained that the physical properties of each of the layers (particularly the thin film protecting film 50) forming the optical information recording medium 10 are set by using the materials characteristics of these layers, so that the neutral plane of deformation caused by a temperature change is present within (or in the vicinity of) the thin film layer 40. However, in general, each layer forming the thin film layer 40 of the optical information recording medium 10 is so thin that the thin film layer 40 can be deemed as a single layer, and the physical properties of each layer (particularly the thin film protecting film 50) may be set in such a manner that the bending moments applied on the thin film layer 40 in response to a temperature change from the both sides (the transparent substrate 20 and substrate protecting film 30 side and the thin film protecting film 50 side) are substantially cancelled out with each other. In this case, warpage of the thin film layer 40 caused by a temperature change can be also eliminated almost completely. By taking the fact that the transparent substrate 20 has a considerable thickness into consideration, in order to reduce the thickness of the thin film protecting film 50 (30 μm or less (preferably 20 μm or less)), at least one of the linear expansion coefficient (α) and Young's modulus (E) of the thin film protecting film 50 has to be larger than those of the transparent substrate 20.

② Examples 1 and 2 and Comparative Example 1

[0048] Next, the following will explain examples of the optical information recording medium 10 formed based on the above principle. In Examples 1 and 2 and Comparative Example 1, the thin film layer 40 was made of an aluminum nitride layer alone. This is because, in most of the cases, deformation of the thin film layer 40 is caused by the dielectric layer made of aluminum nitride, etc. Also, in Examples 1 and 2 and Comparative Example 1, the substrate protecting film 30 was omitted. Thus, it should be appreciated that when the substrate protecting film 30 is formed, the physical properties of each layer (particularly the thin film protecting film 50) have to be set in consideration of the presence of the substrate protecting film 30.

[0049] A medium formed as Example 1 included a substrate (transparent substrate) 20 made of polycarbonate, on which an aluminum nitride thin film layer (thin film layer 40), and UV curable resin 1 (thin film protecting film 50) designed under the conditions in accordance with Equations (1) through (5) above were formed. An optical information recording medium formed as Comparative Example 1 included a polycarbonate substrate, on which an aluminum nitride thin film layer and convectional UV curable resin 2 (thin film protecting film) were formed. The arrangements of Example 1 and Comparative Example 1 are set forth in Table 1 and Table 2 below.

Table 1

Example 1				
	MATERIAL	FILM THICKNESS	YOUNG'S MODULUS (Pa)	LINEAR EXPANSION COEFFICIENT (1/°C)
TRANSPARENT SUBSTRATE	POLYCARBONATE	0.6 mm	2.41E+09	6.00E-05
THIN FILM LAYER	ALUMINUM NITRIDE	79 nm	3.43E+11	5.60E-06
THIN FILM PROTECTING FILM	UV CURABLE RESIN 1	16 μm	1.80E+09	7.10E-05

Table 2

Comparative Example 1				
	MATERIAL	FILM THICKNESS	YOUNG'S MODULUS (Pa)	LINEAR EXPANSION COEFFICIENT (1/°C)
TRANSPARENT SUBSTRATE	POLYCARBONATE	0.6 mm	2.41E+09	6.00E-05
THIN FILM LAYER	ALUMINUM NITRIDE	79 nm	3.43E+11	5.60E-06
THIN FILM PROTECTING FILM	UV CURABLE RESIN 2	15 μm	1.80E+09	5.62E-05

[0050] Table 1 and Table 2 reveal that the difference between Example 1 and Comparative Example 1 was the liner expansion coefficient of the UV curable resin (thin film protecting film 50), and the one having a larger linear expansion coefficient was used in Example 1. As the transparent substrate 20, a disk having the minor diameter of 15 mm and the major diameter of 120 mm was used in both Example 1 and Comparative Example 1.

[0051] A temperature change (T=30°C) was given to the media of Example 1 and Comparative Example 1 (temperatures of the media were raised from 25°C to 55°C), and a variation of warpage angles θ at the outer circumference portion (r=56 mm) with time was analyzed. The reason why a variation of warpage angles was analyzed instead of the warpage angles itself is because the medium has its own warpage angles at normal temperature, and the warpage angles itself does not precisely represent deformation caused by a temperature change.

[0052] Figure 4 shows the analysis results. Both the largest variation and normal state value of variation of warpage angles of the medium of Example 1 were smaller than those of the medium of Comparative Example 1. Thus, it is understood that deformation was suppressed in the medium of Example 1. Figure 4 reveals that, according to Example 1, even if the film thickness was 20 μm or less, no significant temporal warpage occurred in response to a temperature change. Further, Figure 4 also shows predicted variations of warpage angles θ calculated in accordance with Equations (1) through (5) above, and these predicted approximate values were very close to the actual values, thereby proving reliability of the approximate values.

[0053] Next, the following will explain a medium (Example 2) using UV curable resin 3 having large Young's modulus. The medium of Example 2 had different UV curable resin characteristics from those in the medium of Example 1. The arrangement of Example 2 is set forth in Table 3 below.

Table 3

Example 2				
	MATERIAL	FILM THICKNESS	YOUNG'S MODULUS (Pa)	LINEAR EXPANSION COEFFICIENT (1/°C)
TRANSPARENT SUBSTRATE	POLYCARBONATE	0.6 mm	2.41E+09	6.00E-05
THIN FILM LAYER	ALUMINUM NITRIDE	79 nm	3.43E+11	5.60E-06
THIN FILM PROTECTING FILM	UV CURABLE RESIN 3	16 μm	3.60E+09	5.68E-05

[0054] A variation of warpage angles θ predicted by calculations in accordance with Equations (1) through (5) above was 5.18 mrad, and it is understood that warpage caused by a temperature change was reduced significantly compared with Comparative Example 1.

[0055] As has been discussed, according to the optical information recording medium of the present embodiment,

temporal significant warpage caused by a temperature change can be suppressed. Thus, even when the temperature of the medium rises while information is recorded or reproduced, problems, such as defective reproduction, can be controlled. In addition, the thin film protecting film 50 can be made thinner.

(Embodiment 2)

[0056] The present embodiment will explain an optical information recording medium which can prevent deformation caused by a humidity change.

① Principle

[0057] The optical information recording medium 10 of Figure 1 employs the substrate made of polycarbonate or the like as the transparent substrate 20. Thus, under high humidity circumstances, the transparent substrate 20 absorbs moisture and expands, thereby causing deformation of the optical information recording medium 10. In particular, when a moisture permeation degree of the substrate protecting film 30 is greater than that of the thin film protecting film 50, a deformation rate of the substrate 20 becomes faster than that of the thin film protecting film 50. Accordingly, large overshoot of a variation occurs when humidity actually changes, thereby raising a serious problem.

[0058] In the present embodiment, the above problem occurring in practical use is solved by suppressing the overshoot by making a moisture permeation degree of the substrate protecting film 30 smaller than that of the thin film protecting film 50.

② Example

[0059] A medium formed as Example 3 was identical with the medium of Example 1 above except that the substrate protecting film 30 made of UV curable resin 4 was additionally provided. A medium formed as Comparative Example 2 for purpose of comparison was also identical with the medium of Example 1 except that the substrate protecting film 30 made of UV curable resin 5 was additionally provided. Moisture permeation degrees of the UV curable resins of Example 3 and Comparative Example 2 are set forth in Table 4 below.

Table 4

	SUBSTRATE PROTECTING FILM		THIN FILM PROTECTING FILM	
	FILM	MOISTURE PERMEATION DEGREE ($g/m^2 \cdot day$)	FILM	MOISTURE PERMEATION DEGREE ($g/m^2 \cdot day$)
EXAMPLE 3	UV CURABLE RESIN 4	2.20E+02	US CURABLE RESIN 1	4.60E+02
COMPARATIVE EXAMPLE 2	UV CURABLE RESIN 5	9.70E+02	UV CURABLE RESIN 1	4.60E+02

[0060] A humidity change was given to the media of Example 3 and Comparative Example 2 (ambient humidity was increased from 50% to 90%), and a variation of warpage angles θ at the outer circumference portion (r=56 mm) with time was analyzed.

[0061] Figure 5 shows the analysis result. The largest variation (at the overshoot) of warpage angles in Example 3 was quite small compared with that in Comparative Example 2, and it is understood that deformation caused by a humidity change was suppressed in the medium of Example 3.

[0062] The foregoing principles stand up for polycarbonate substrates or the like thinner than those used in Examples 1 through 3, which will be explained in Example 4 as follows.

[0063] A medium formed as Example 4 was identical with the medium of Example 3 except that the thickness of the substrate (transparent substrate) 20 was 0.5 mm (the arrangements are set forth in Table 5 below), and a variation of warpage angles θ in response to the temperature change and humidity change was analyzed.

Table 5

	MATERIAL	FILM THICKNESS	YOUNG'S MODULUS (Pa)	LINEAR EXPANSION COEFFICIENT (1/°C)	MOISTURE PERMEATION DEGREE ($g/m^2 \cdot day$)
SUBSTRATE PROTECTION FILM	UV CURABLE RESIN 6	3 μm	6.8E+09	5.0E-05	2.2E+02
TRANSPARENT SUBSTRATE	POLYCARBONATE	0.5 MM	3.3E+09	6.0E-05	
THIN FILM LAYER	ALUMINUM NITRIDE	79 nm	3.4E+11	5.6E-06	
THIN FILM PROTECTING FILM	UV CURABLE RESIN 7	12 μm	5.9E+09	7.2E-05	4.6E+02

[0064] Figures 10 and 11 show the analysis results. Figure 10 shows a transitional variation of tilt along radius in response to a temperature Change (a change from 25°C at 50% to 70°C at 30% was given), and Figure 11 shows a variation of tilt along radius in response to a humidity change (a change from 25°C at 60% to 25°C at 90% was given). The transparent substrate 20 had a minor diameter of 7 mm and a major diameter of 50 mm. The analysis results reveal that the foregoing principles stand up even in a case where a thinner transparent substrate 20 is used, and therefore, a variation of warpage can be also suppressed in such a case.

[0065] As has been discussed, according to the optical information recording medium of the present embodiment, even if humidity changes, no temporal significant warpage occurs, thereby suppressing a problematic defective reproduction when information is recorded and reproduced.

[0066] In the optical information recording medium of the present embodiment, if the physical properties of the thin film protecting film 50 and substrate protecting film 30 are set so as to form the neutral plane of deformation caused by a temperature change within (or in the vicinity of) the thin film layer 40 as was discussed in Embodiment 1, not only can deformation caused by a humidity change be prevented as was discussed herein, but also deformation caused by a temperature change can be prevented.

[0067] As has been discussed, in the present invention, by arranging the optical information recording medium in such a manner that the neutral plane of deformation caused by a temperature change is present within (or in the vicinity of) the thin film layer, such as a magnetic film, a variation caused by a temperature change can be reduced, thereby enhancing information recording and reproducing reliability.

[0068] Also, in the optical information recording medium, by making at least one of Young's modulus and linear expansion coefficient of the thin film protecting film larger than those of the transparent substrate, the thin film protecting film can be made thinner. Consequently, the optical information recording medium can be readily manufactured. Moreover, in case of a magneto-optical recording medium, the magnetic characteristics can be improved.

[0069] In addition, by providing a substrate protecting film having a smaller moisture permeation degree than that of the thin film protecting film, a variation caused by a humidity change can be reduced, thereby enhancing information recording and reproducing reliability.

[0070] An optical information recording medium of the present invention, including at least a transparent substrate, a thin film layer formed on the transparent substrate and having at least one of a recording film and a reflecting film, and a thin film protecting film formed on the thin film layer and mainly made of resin, may be arranged in such a manner that the neutral plane of deformation in the film thickness direction caused by a temperature change while information is recorded and reproduced is present in the vicinity of the thin film layer.

[0071] Also, an optical information recording medium of the present invention, including at least a transparent substrate, a thin film layer formed on the transparent substrate and having at least one of a recording film and a reflecting film, and a thin film protecting film formed on the thin film layer and mainly made of resin, may be arranged in such a manner that bending moments applied on the thin film layer from the both sides in the film thickness direction are substantially equal.

[0072] In addition, an optical information recording medium of the present invention, including at least a transparent

substrate, a thin film layer formed on the transparent substrate and having at least one of a recording film and a reflecting film, and a thin film protecting film formed on the thin film layer and mainly made of resin, may be arranged in such a manner that at least one of Young's modulus and the linear expansion coefficient of the thin film protecting film is larger than those of the transparent substrate, respectively.

[0073] Further, an optical information recording medium of the present invention may be arranged in such a manner that the film thickness of the thin film protecting film is 20 μm or less.

[0074] In addition, an optical information recording medium of the present invention, including at least a transparent substrate, a thin film layer formed on the transparent substrate and having at least one of a recording film and a reflecting film, a thin film protecting film formed on the thin film layer and mainly made of resin, and a substrate protecting film formed on the light incident side of the transparent substrate and mainly made of resin, may be arranged in such a manner that a moisture permeation degree of the thin film protecting film is smaller than that of the substrate protecting film.

[0075] The neutral plane of deformation referred to herein means a plane expressed by a value of y when warpage angles θ is almost 0 (zero) in Equations (1) through (5) above.

[0076] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. An optical information recording medium including:

    a thin film layer (40), formed on a substrate (20), for recording and reproducing information; and
    a thin film protecting film (50), formed on said thin film layer (40), for protecting said thin film layer (40),
    a neutral plane of deformation in a thickness direction caused by a temperature change being present in a vicinity of said thin film layer (40).

2. An optical information recording medium including:

    a thin film layer (40), formed on a substrate (20), for recording and reproducing information; and
    a thin film protecting film (50), formed on said thin film layer (40), for protecting said thin film layer (40),
    bending moments applied on said thin film layer (40) from a substrate (20) side and a thin film protecting film (50) side in response to a temperature change being substantially cancelled out with each other.

3. The optical information recording medium of Claim 1, wherein a thickness, Young's modulus, and a linear expansion coefficient are set to their respective desired values in each of said substrate (20), thin film layer (40), and thin film protecting film (50), so that the neutral plane of deformation in the thickness direction caused by a temperature change is present in the vicinity of said thin film layer (40).

4. The optical information recording medium of Claim 3, wherein at least one of Young's modulus and the linear expansion coefficient of said thin film protecting film (50) is larger than one of Young's modulus and the liner expansion coefficient of said substrate (20), respectively.

5. The optical information recording medium of Claim 3, wherein the thickness of said thin film protecting film (50) is 20 μm or less.

6. The optical information recording medium of Claim 1, further including a substrate protecting film (30), formed on said substrate (20) on a surface opposite to a surface where said thin film layer (40) is formed, for protecting said substrate (20), a moisture permeation degree of said substrate protecting film (30) being smaller than a moisture permeation degree of said thin film protecting film (50).

7. An optical information recording medium including:

    a thin film layer (40), formed on a substrate (20), for recording and reproducing information;
    a thin film protecting film (50), formed on said thin film layer (40), for protecting said thin film layer (40); and
    a substrate protecting film (30), formed on said substrate (20) on a surface opposite to a surface where said thin film layer (40) is formed, for protecting said substrate (20),
    a moisture permeation degree of said substrate protecting film (30) being smaller than a moisture permeation degree of said thin film protecting film (50).

8. An optical information recording medium at least including:

a transparent substrate (20);
a thin film layer (40) formed on said transparent substrate (20) and having at least one of a recording film (42) and a reflecting film (44); and
a thin film protecting film (50) formed on said thin film layer (40) and mainly made of resin,
a neutral plane of deformation in a film thickness direction caused by a temperature change while information is recorded and reproduced being present in a vicinity of said thin film layer (40).

9. An optical information recording medium at least including:

a transparent substrate (20);
a thin film layer (40) formed on said transparent substrate (20) and having at least one of a recording film (42) and a reflecting film (44); and
a thin film protecting film (50) formed on said thin film layer (40) and mainly made of resin,
bending moments applied on said thin film layer (40) from both sides thereof in a film thickness direction being substantially equal.

10. An optical information recording medium at least including:

a transparent substrate (20);
a thin film layer (40) formed on said transparent substrate (20) and having at least one of a recording film (42) and a reflecting film (44); and
a thin film protecting film (50) formed on said thin film layer (40) and mainly made of resin,
at least one of Young's modulus and a linear expansion coefficient of said thin film protecting film (50) being larger than one of Young's modulus and a liner expansion coefficient of said transparent substrate (20), respectively.

11. The optical information recording medium of Claim 8, 9, or 10, wherein a film thickness of said thin film protecting film (50) is 20 μm or less.

12. An optical information recording medium at least including:

a transparent substrate (20);
a thin film layer (40) formed on said transparent substrate (20) and having at least one of a recording film (42) and a reflecting film (44);
a thin film protecting film (50) formed on said thin film layer (40) and mainly made of resin; and
a substrate protecting film (30) formed on a light incident side of said transparent substrate (20) and mainly made of resin,
a moisture permeation degree of said substrate protecting film (30) is smaller than a moisture permeation degree of said thin film protecting film (50).

FIG. 1

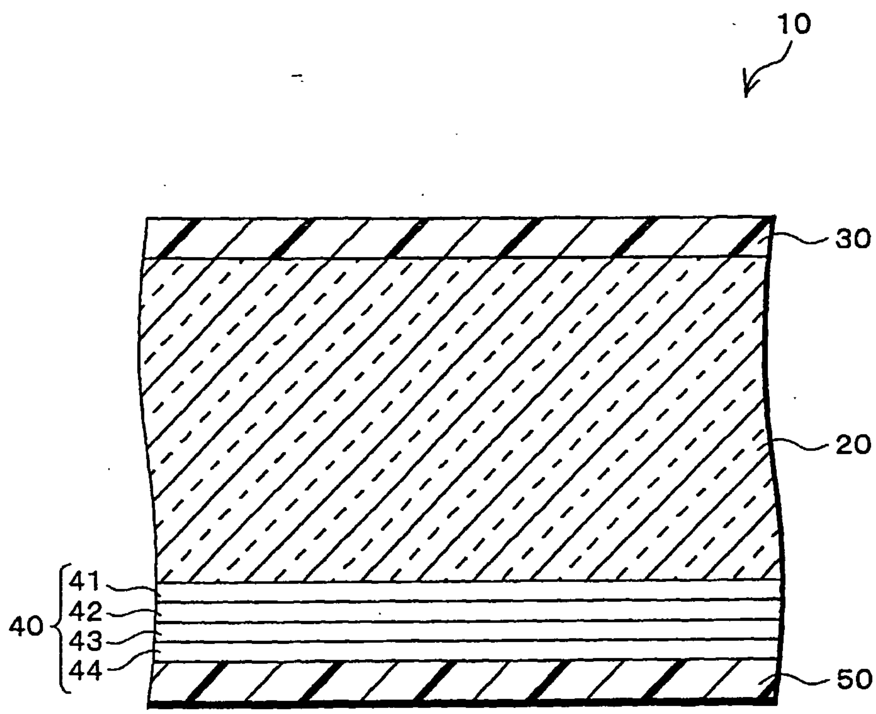
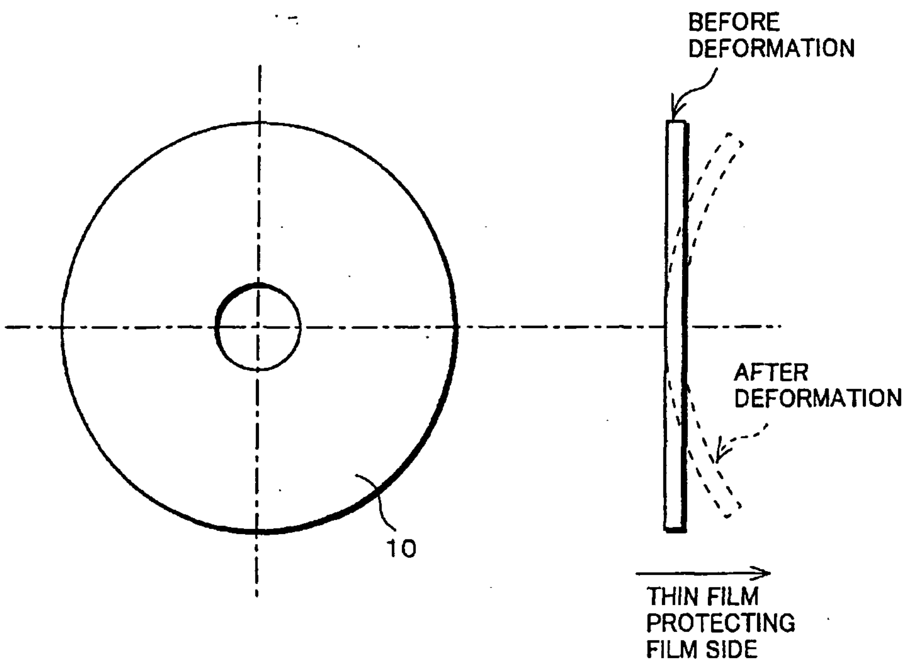


FIG. 2 (a)   FIG. 2 (b)


BEFORE
DEFORMATION
AFTER
DEFORMATION
10
THIN FILM
PROTECTING
FILM SIDE

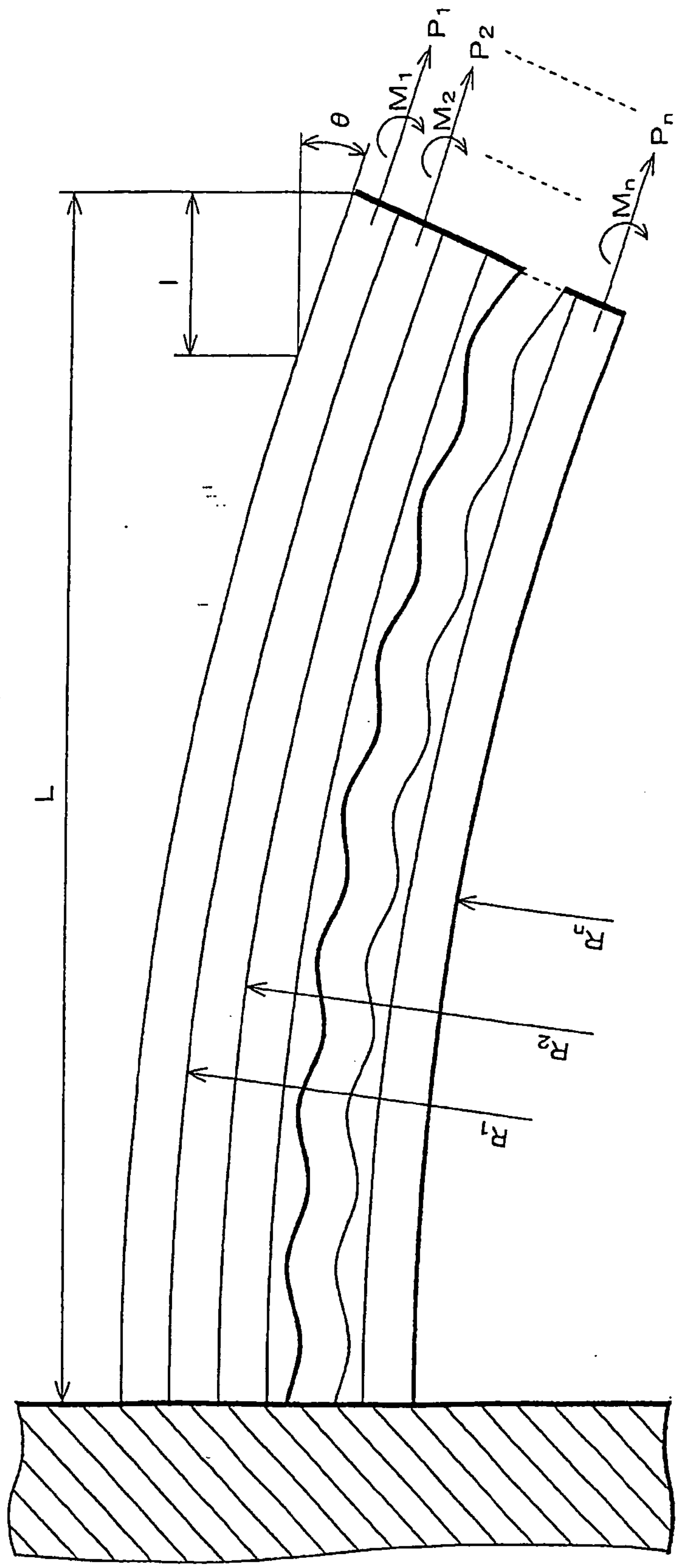


FIG. 3

FIG. 4

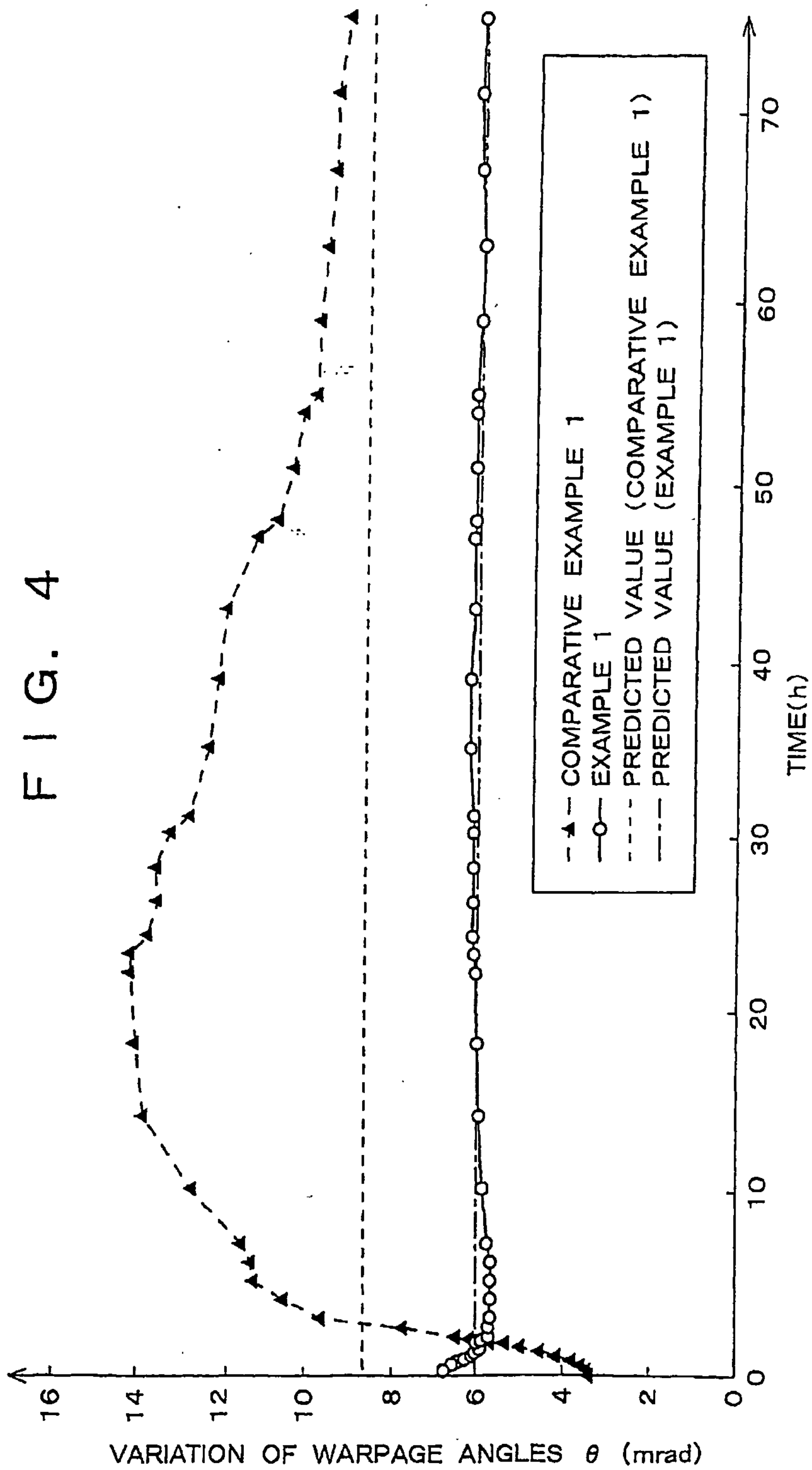

COMPARATIVE EXAMPLE 1
EXAMPLE 1
PREDICTED VALUE (COMPARATIVE EXAMPLE 1)
PREDICTED VALUE (EXAMPLE 1)
TIME(h)
0
10
20
30
40
50
60
70
VARIATION OF WARPAGE ANGLES θ (mrad)
0
2
4
6
8
10
12
14
16

FIG. 5

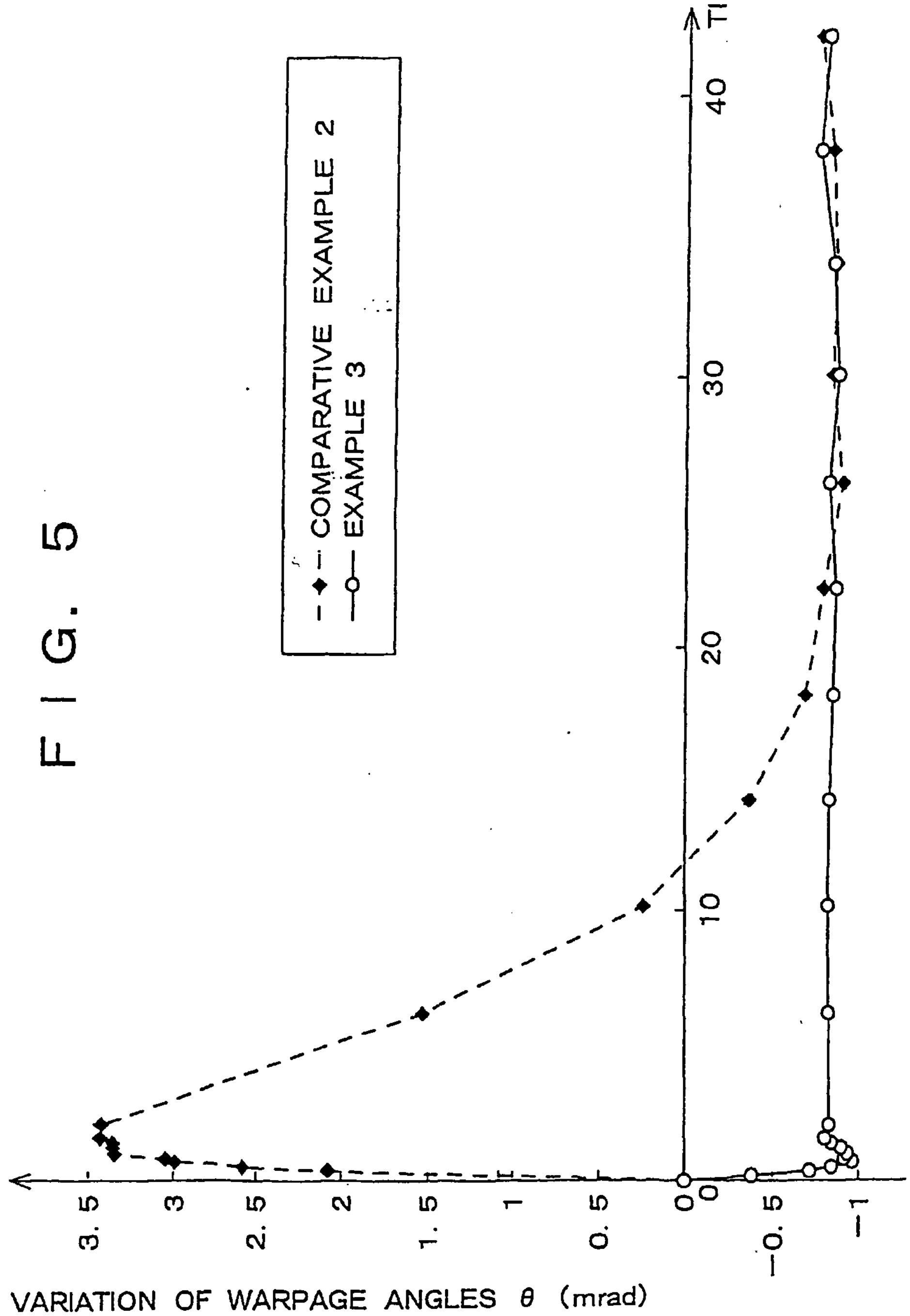

COMPARATIVE EXAMPLE 2
EXAMPLE 3
TIME(h)
0
10
20
30
40
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
VARIATION OF WARPAGE ANGLES θ (mrad)

FIG. 6 (a)

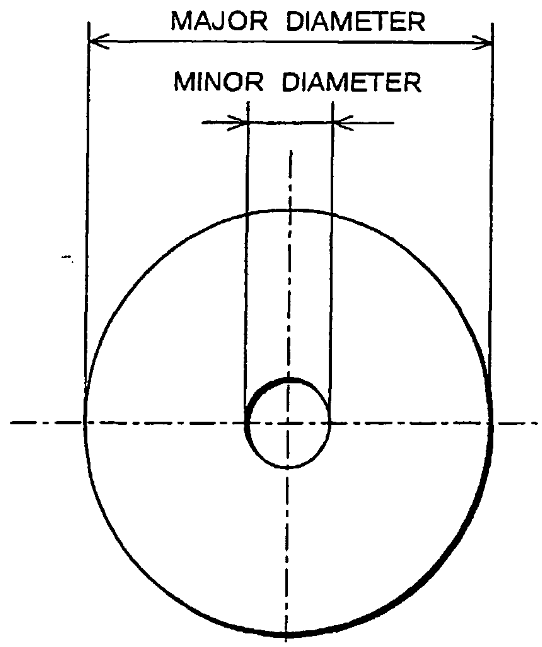


FIG. 6 (b)

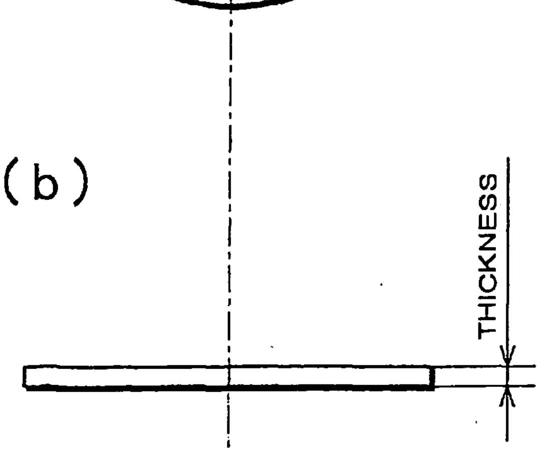


FIG. 7

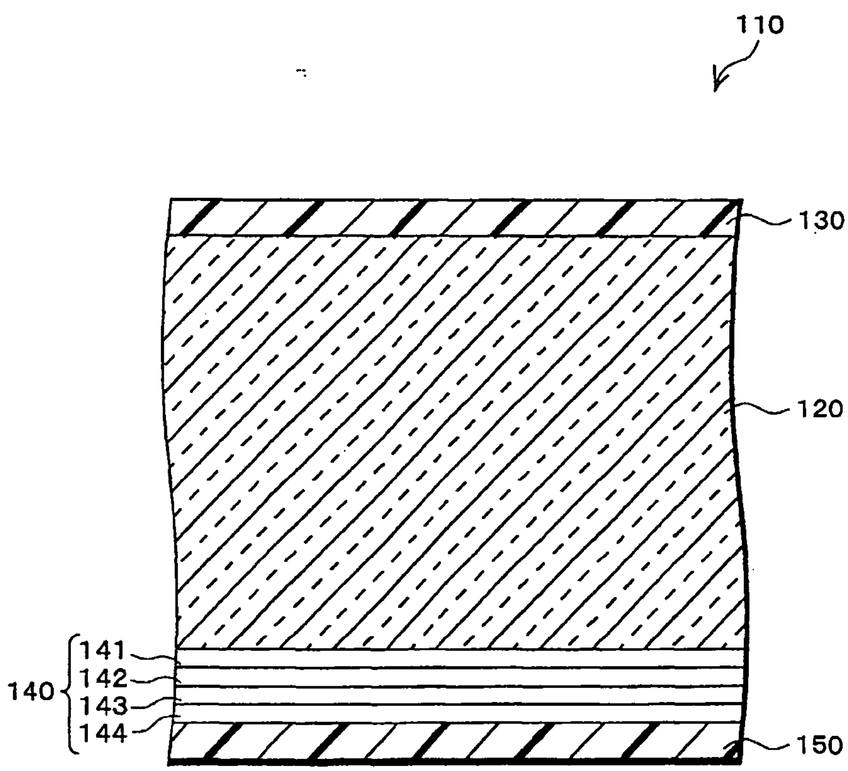


FIG. 8

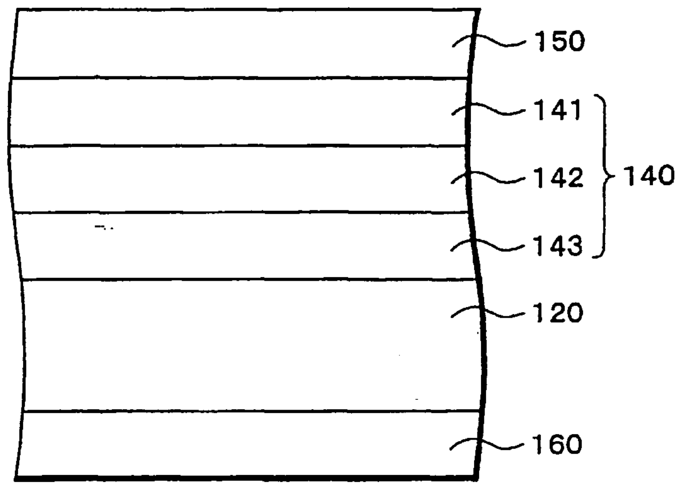


FIG. 9

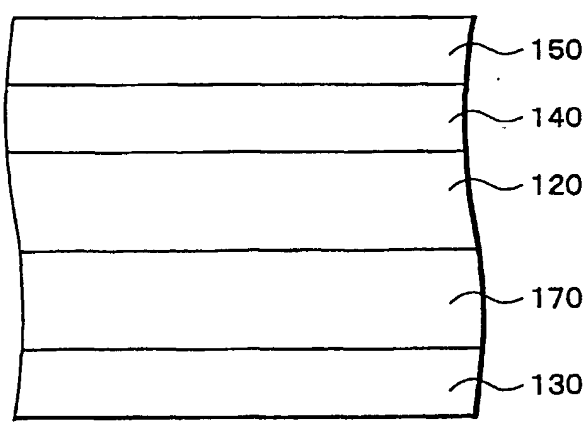
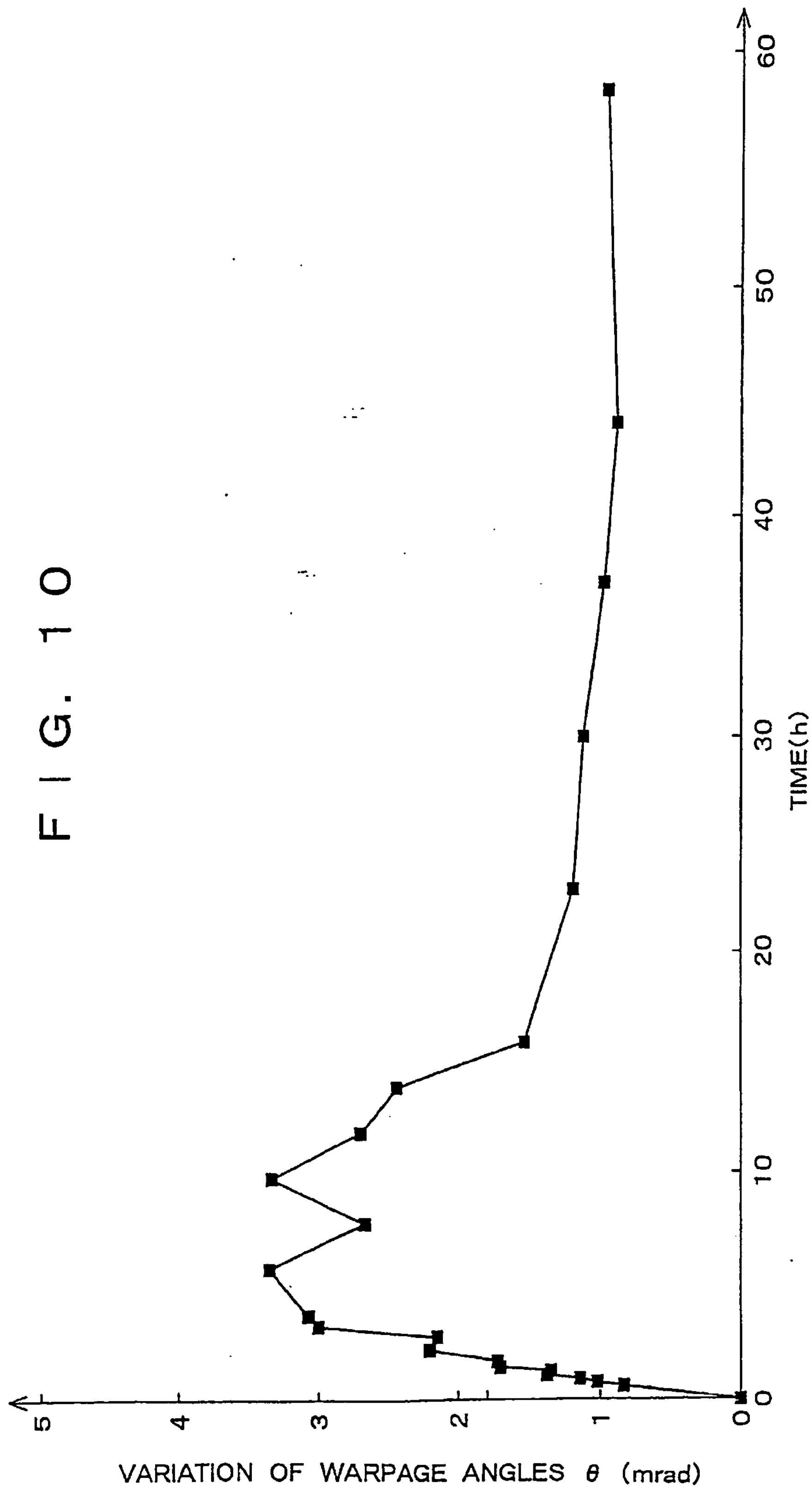
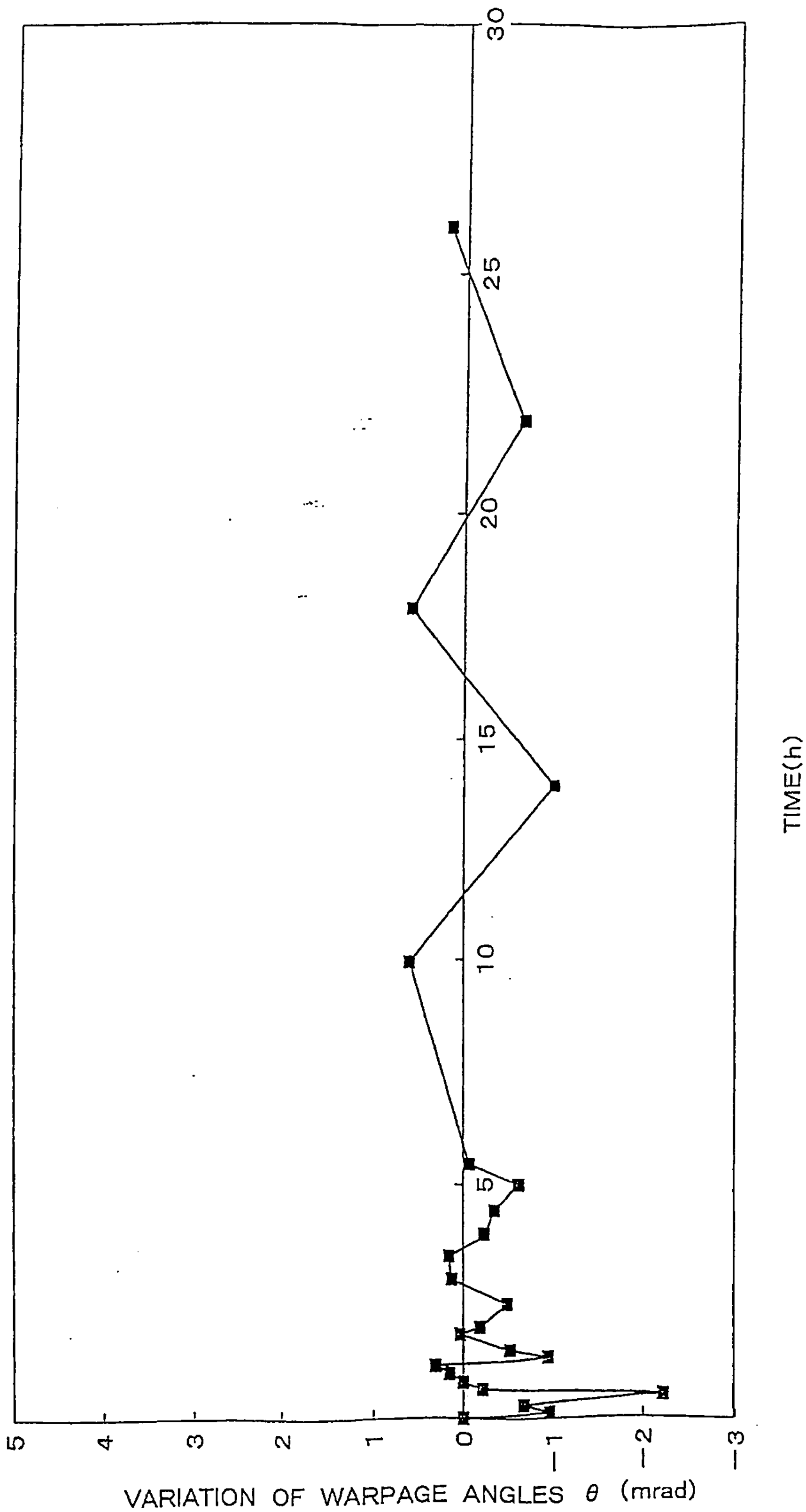


FIG. 10



VARIATION OF WARPAGE ANGLES θ (mrad)
0
1
2
3
4
5
TIME(h)
0
10
20
30
40
50
60

FIG. 11


5
4
3
2
1
0
−1
−2
−3
VARIATION OF WARPAGE ANGLES θ (mrad)
5
10
15
20
25
30
TIME(h)

Murakami neither discloses nor suggests imposing such a performance requirement on the materials used for the optical recording medium recited therein. Moreover, no extrinsic evidence has been presented to show or establish that the protective layers or transparent substrates of the optical recording media of Murakami necessarily possess the linear expansion coefficients recited in claims 10 and 14, as currently amended.

Applicants respectfully submit that the materials disclosed in the Murakami reference do not necessarily possess the properties of the claimed invention. Materials described in similar general terms can and often do have quite different properties, including different linear expansion coefficients. For example, as shown on the attached Table (Exhibit A), materials generically termed "acrylic UV curable resins" having similar principal components can nevertheless have a range of linear expansion coefficients (in the Table, ranging from about 1.10 $\times 10^{-5}$ to about 1.46×10^{-4} (l/°C) (note that the acrylic ester commercial product listed at the bottom of the Table does not have a linear expansion coefficient within the range required by the instant claims). It is clear that a reference disclosing an acrylic UV curable resin would not necessarily provide a disclosure of an acrylic UV curable resin having a linear expansion coefficient *in a specific range*. So it is with the Murakami reference, which at the portion cited by the Examiner (Column 8, lines 47-49), states that an "overcoat film" can be an "ultraviolet hardening resin from polyurethane acrylate series." This disclosure does not expressly nor inherently describe a protective film having a linear expansion coefficient of the greater than 9.5×10^{-5} (l/°C) and smaller than 5.0×10^{-4} (l/°C), as required by the pending claims. Therefore, the Murakami reference does not and cannot anticipate the pending claims.

For at least the reasons discussed herein, claims 10, 14, and 18 are patentable over the Murakami patent (Applicants note that claims 17-22 were not rejected under 35 U.S.C. §102(b) over Murakami). Claims 11-13, 15-17, and 19-22 depend from claims 10, 14 or 18 and are therefore also patentable over the Murakami patent.

Separate Sheet A

Acrylic UV Curable Resin		Liner Expansion Coefficient of Protective Film (1/K)
Acrylic UV Curable Resin	Principal Components	
A	Mixture of Acrylate Oligomer (Acrylic Ester), Acrylate Monomer, and Photopolymerization Initiator	9.70E-05
B		1.17E-04
C		1.15E-04
D		1.10E-04
E		1.12E-04
F		1.17E-04
G		1.13E-04
H		1.10E-04
I		1.15E-04
J		6.38E-05
K		8.60E-05
L		1.10E-05
M		1.46E-04
Commercial Acrylic UV Curable Resin	Acrylic Ester Compound	6.01E-05

Note: Acrylic UV curable resins A-M are not commercial products, but are test products whose names are not given.

Claims 10-16 were rejected under 35 U.S.C. §102(b) as being allegedly anticipated by Tachibana (U.S. Patent 5,102,709), and claims 10-22 were rejected under 35 U.S.C. §103(a) as being allegedly obvious in view of Tachibana.

The resin composition disclosed in Example 3 of Tachibana (KAYARAD DPCA-30 (70%), KAYARAD R-604 (25%), IRG-184, 5%) has a linear expansion coefficient of 9.0×10^{-5} (1/°C). As the Examiner will appreciate, this linear expansion coefficient is not within the range of values of the linear expansion coefficient recited by the pending claims (greater than 9.5×10^{-5} (1/°C) and smaller than 5.0×10^{-4}(1/°C)). Thus, this composition does not in fact possess the properties of the claimed invention, and cannot anticipate the pending claims. Applicants submit that there is no teaching or suggestion in Tachibana that the this resin or any other materials disclosed therein <u>necessarily possess</u> all the properties recited in the pending claims. Accordingly, the rejection of the pending claims is improper and should be withdrawn.

Reconsideration and allowance of claims 10-22 is respectfully requested in view of the foregoing discussion.

<u>Conclusion</u>

This case is believed to be in condition for immediate allowance. Applicant respectfully requests early consideration and allowance of the subject application.

Although no extension of time is believed to be required, Applicants conditionally petition for any extension of time needed. If for any reason a fee is required, a fee paid is inadequate or credit is owed for any excess fee paid, you are hereby authorized and requested to charge Deposit Account No. **04-1105**.